



Materials Engineering Branch

TIP*



No. 048 Use of Oil Lubricants in Spacecraft

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Oil lubricants are generally recommended for ball bearings in spacecraft mechanisms because they offer the smoothest operation, are easily applied, can be replenished, protect the bearing from corrosion and can be tailored to the application regarding viscosity and volatility. The oil that is selected should be able to establish a fluid film between the moving metal surfaces in order to minimize metal-to-metal contact. Fine surface finishes enhance the separation of the surfaces by thin fluid films. These finishes should be less than two micro inches, rms. Soft-metal ball cages should not be used in bearings that are required to make many ($>10^6$) service cycles. If porous ball cages are used, they should be thoroughly cleaned (preferably in a Soxhlet extractor), vacuum dried and vacuum impregnated with the oil to be used.

The choice of oils must take into account the operating and survival temperature ranges; the bearing material; operating speed, load and geometry of the bearing; required life; outgassing issues and other factors. Some oil types (and specific examples) that have aerospace heritage include perfluoropolyethers (Castrol Industries' Brayco 815z, DuPont's Krytox 143 AL), synthetic hydrocarbons (Pennzoil's Pennzane X2000, Nye Lubricants' Nye 179) and refined mineral oils (Apiezon C).

Regardless of the oil used, the bearing should be weighed to the nearest tenth of a milligram before and after the addition of the oil in order to determine the quantity of lubricant. The lubricated bearings should be tightly packaged in heat sealed clean polyethylene envelopes so that they are unable to slide around and wick out the oil. Anti-creep barrier films as specified in Mil-B-81744 Rev. A (AS) can be applied to surfaces adjacent to the bearings to minimize surface migration of the oils.

Labyrinth seals should be designed into the mechanism to inhibit the loss of oil, especially when the more volatile oils are used. Be aware that most lubricants, including the majority of those mentioned here, do not meet the acceptable vacuum outgassing criteria. They are acceptable for space flight use only when the proper design precautions are taken. Each use of a lubricant is approved on the merits of the specific application that take into

account such factors as: usage temperature requirements, loads, speeds, continuous or intermittent operation, labyrinth or hermetic seals, etc.

CAUTION: As TCP is insoluble in the perfluorinated polyether oils, it should not be used as an additive to that oil; nor should it be used to precondition (coat) components that will be lubricated with a perfluorinated polyether oil. The reader is encouraged to review Tip #70 entitled, "Enhancing Lubrication with TCP."